EEGRC Poster: Using Super Heroes to Relay Biomechanics Principles in Education

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BACKGROUND

Recent literature has supported student-centered learning to promote positive learning outcomes and encourages students to take ownership of their learning [1]. There has been a recent push by the American Society of Biomechanics (ASB), as evidenced by the first annual National Biomechanics Day and 2016 K-12 Outreach Expo, to compile and present 'hands-on' biomechanics demonstrations and lab activities to get K-12 school age students excited about Science, Technology, Engineering and Mathematics (STEM) by showcasing the field of biomechanics to the general public [2]. In a new class offered by the University of Delaware Mechanical Engineering department entitled the "Biomechanics of Super Heroes", the authors developed a group project to encourage student-centered learning through the medium of biomechanics and super heroes.

OBJECTIVES

The aim of this study was to develop, implement, and evaluate a student-centered learning project for students to create a video and lesson plan that could be used or recreated by high school teachers to describe biomechanics principles through the medium of science fiction and super heroes.

RESEARCH DESIGN

Students (n = 16) worked in pairs to prepare the following educational materials to describe a biomechanics concept aimed for high school students:

1. Short educational video uploaded to YouTube® describing biomechanics concept and corresponding in-class learning activity.
2. Lesson Plan with step by step directions for completing corresponding in-class activity (i.e. worksheet, thought problem, demonstration) along with list of materials/costs.

Students were provided an example lesson plan and video based on the ASB K-12 Outreach Expo [2] (Figure 1), resources to video editing software, and a grading rubric (Figure 2). The instructor of record graded all projects based on the video and lesson plan submitted using the rubric.

Topic	**Take home point**
YouTube Video	
Title: :	
Link: https://www.youtube.com/xxx	
Supplies	
Demo: Title *(if applicable)* - Supply list **Estimated Cost: $**	
Directions	
1. All submissions must include a YouTube video (max 3 minutes) and a written lesson plan on the provided template (P1_Activity_Template.docx). 2. Include figures or pictures as necessary. 3. Demos and lessons should be geared towards high school students (grades 9-12) 4. Maximum of 3 pages. 5. Criteria for selection will include: a. activity topic b. clarity of description and video c. cost and time required for the activity Full criteria for judging can be found here: (P1_Activity_Rubric.docx)	
Recommendations for Classroom Implementation	
Additional Information *(Optional)*	

Estimated Cost Justification:

Demo: Title *(if applicable)*		**Lab Activity: Title** *(if applicable)*	
Item	*Subtotal*	*Item*	*Subtotal*
*Add or subtract rows as needed			
Total	**$**	**Total**	**$**

Figure 1. Template for Lesson Plan (adapted from ASB K12 Outreach Expo) [2].

	10	8	6	4	Score
Topic	The topic is relevant to biomechanics and super heroes and clearly identified	The topic is relevant to biomechanics and super heroes but is stated in a somewhat unclear manner	The topic is loosely relevant to biomechanics or super heroes and is stated in a somewhat unclear manner	The topic is erroneous or irrelevant to biomechanics or super heroes.	/10
Clarity of video	Video is all of the following: 1. Clearly presented 2. Relevant to the instruction of the topic 3. Engaging for the target audience (HS)	Video is 2 of the following: 1. Clearly presented 2. Relevant to the instruction of the topic 3. Engaging for the target audience (HS)	Video is 1 of the following: 1. Clearly presented 2. Relevant to the instruction of the topic 3. Engaging for the target audience (HS)	Video is **none** of the following: 1. Clearly presented 2. Relevant to the instruction of the topic 3. Engaging for the target audience (HS)	/10
Clarity of lesson plan	Lesson plan is easy to read and all elements are clearly written, labeled or drawn that another person could execute the contents	Lesson plan is easy to read and most elements are clearly written, labeled or drawn. Another person might be able to execute the contents after asking one or two questions.	Lesson plan is not clearly written. It would be hard for another person to execute the contents without asking lots of questions.	Lesson plan is hard to read and one cannot tell what goes where. It would be impossible for another person to execute the contents without asking lots of questions.	/10
Time	Can be completed in 15 minutes or less			Cannot be completed in 20 minutes or less.	/10
Analysis	All components are accurate	One error is evident.	Two errors are evident.	Several errors are evident.	/10
Cost	0-$50	$51-100	$101-150	>$150	/10
Total					/60

Figure 2. Grading rubric for project.

RESULTS

A list of biomechanics concepts and science fiction medium used by students is listed in Table 1. Overall, students showed creativity in applying the biomechanical concepts (Figure 3). The instructor of record addressed any misconceptions and errors in the students' biomechanical analyses in a written comment with the grade. Despite varying projects, average total scores for the topic, video, lesson, time, analysis, and cost per the rubric were 9, 9, 9, 10, 9, and 10, respectively. The authors noted loss of points in the clarity of video category was most often due to unclear relevance of the biomechanics concepts to super heroes.

Table 1. Biomechanical concepts and science fiction medium selected by sample of students.

Title	**Biomechanics Concept**	**Super hero/Science Fiction medium**
"Is Elastigirl 'Stretchier' than a Rubber band?"	Elasticity and Hooke's Law	Elastigirl
"Super Levers"	Levers in the Human Body	Super heroes with high strength
"Jump To It"	Vertical Jump and energy production	Superman
"Extreme Forces in the Iron Man Armor"	Rapid acceleration/deceleration of human body	Iron Man
"Striking the Superhero Landing"	Landing from height	Deadpool
"Target Practice"	Projectile Motion	Arrow
"Holy Balance, Batman"	Momentum, Center of Mass, Balance	Batman, Robin, Joker
"What's in a Lever"	Levers and Mechanical Advantage	Superman

Figure 3 show example clips from student presentations.

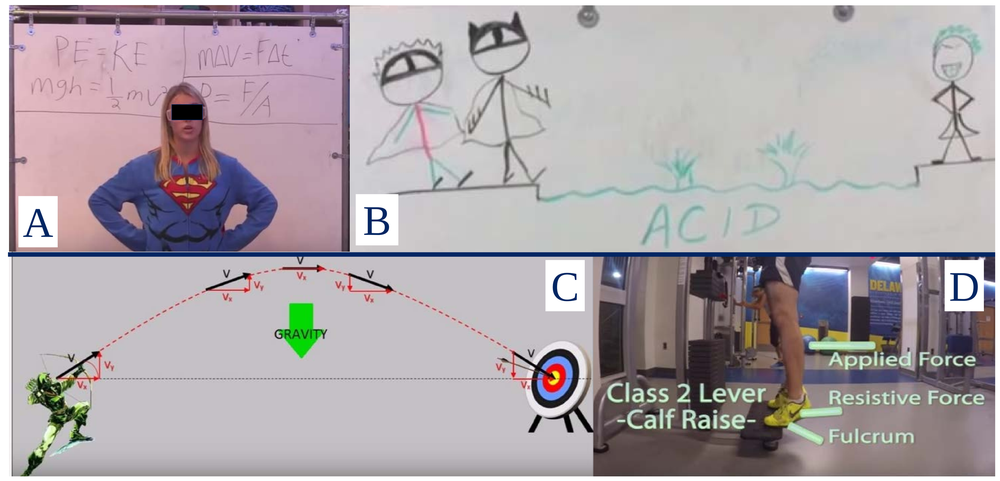

Figure 3. Clips from videos of the following presentations A) Striking the Superhero Landing B) Holy Balance, Batman C) Target Practice D) What's in a lever.

CONCLUSIONS

Overall, this video project used a student-centered learning strategy and a fun medium of fictional superhero characters to promote outreach education in the STEM curriculum. Students presented creative applications of biomechanical concepts learned in class, which supports one of the ABET student outcomes for students to have "an ability to apply knowledge of mathematics, science, and engineering" [3]. Instructors replicating this project may consider having students submit a storyboard in order to give feedback on the relevance of the biomechanics concepts to super heroes prior to the final submission. Future work may implement these lessons to high school classrooms and assess student outcomes as a result.

SUPPLEMENTAL MATERIAL

Students also completed a peer evaluation based on the Oral Communication Valid Assessment of Learning in Undergraduate Education (VALUE) rubric from the Association of American Colleges and Universities (AACU) [4]. Figure 4 shows the adapted VALUE rubric which students completed for each presentation.

Project 1 Peer Evaluation

Project Topic/Activity: _____

Please clearly mark your score for each category with an X or check:

	4	3	2	1
Organization	Cohesive and organized presentation of content			Organization is not observable in presentation
Language	Language is memorable and compelling, appropriate for target audience			Language is unclear and inappropriate for target audience
Delivery	Delivery is compelling, presenters are polished and confident			Delivery detracts from understanding of presentation, presenters are uncomfortable
Supporting Material	Supporting examples, analogies, etc. are used to support the topic			Insufficient supporting materials that minimally support the topic
Central Message	Message is compelling, memorable, strongly supported			Message can be deduced but not explicitly stated in presentation.

Adapted from AACU's Oral Communication VALUE rubric

Any other comments (e.g. strengths, weaknesses of the presentation)?

Figure 4. Adapted peer evaluation rubric based on Oral Communication VALUE rubric from AACU [4].

All groups received an average score of 4 from their peers in each category except for the "What's in a Lever" group which received a 3 in Organization and Delivery with students commenting on the lack of clarity in the video. The authors noted that not all comments from students were reflected in the peer evaluation scoring. For example one student commented on "Is Elastigirl 'Stretchier' than a Rubber Band" that the "material seemed a little complicated for the target audience" but proceeded to give the group a 4 in Language. However, several students commented that the videos in general were "fun and engaging", "great, fun, and interesting", and a "good demonstration of the activity".

REFERENCES

[1] M Weimer. *Learner-Centered Teaching*, Jossey-Bass, 2013.

[2] T Giest, et al. *ASB40 Outreach Expo,* http://asb2016.asbweb.org/outreach-expo-call-for-submission-of-biomechanics-demos-and-lab-activities/.

[3] ABET Board of Directors, *Criteria for Accrediting Engineering Programs,* Nov 1 2014.

[4] Association of American Colleges & Universities (AACU), *Oral Communication VALUE Rubric*, https://www.aacu.org/value/rubrics/oral-communication.

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